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Symonds, Brandreth

The value of the medical examiner's opinion

[New York]

1921

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Association of
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The Value of
The Medical Examiner's Opinion

Compliments of
Dr. Brandreth Symonds
7-12-21

By

Brandreth Symonds, A.M., M.D.
Chief Medical Director Mutual Life Insurance Company of New York

1921

THE VALUE OF THE MEDICAL EXAMINER'S OPINION.

By Brandreth Symonds, A.M., M.D.

Chief Medical Director Mutual Life Insurance Company of New York.

Into the selection of risks for life insurance enter a number of factors, medical and others. The value of each factor is problematical. Some thirty years ago the President of one of our great companies said that by the simple process of insuring everyone who walked past the doors of his Company's building on Broadway a mortality would be obtained as low as by the most careful selection then prevalent. Possibly he was right, and that without any reflection on the medical department or other forces instrumental in selecting the risks for his Company. The people walking on that part of Broadway at that time were almost entirely men between 16 and 65, in sufficiently good health to walk 3 or 4 miles an hour. They were financially in at least fair condition as the dead-line was fixed at Fulton Street, and for that same reason most of the men below Fulton Street were of good habits. A few years later the President of another great Company located on Broadway actually made an experiment similar to this by selling small amounts of insurance almost directly to the applicant through little toy banks which could be picked up in the "L" stations and elsewhere. There was no medical examination and practically no investigation. The results of this experiment which lasted for several months have never been published but the Company very suddenly withdrew the privilege, and bought up most of the outstanding policies.

In recent years a vast amount of insurance has been issued

on the group-plan. There is no medical examination of the individuals comprising the group but the medical characteristics of the group as a whole are carefully studied beforehand and in many groups the individuals are urged to maintain their vitality through lectures and pamphlets on sanitation and hygiene. The group primarily is demonstrated to be composed of healthy individuals and elaborate precautions are taken to prevent a group from deteriorating in its composition after insuring. The new cases which enter the group must be up to the original standard of work and capability, and the withdrawals include a large proportion of those who have become unfit for insurance. Unless these conditions are fulfilled, the mortality experience in the group is liable to be bad.

When a medical examination is made for life insurance, the duty of the medical examiner comprises at least two functions, (1) his detection of physical impairments, whether organic or functional, and (2) his ability to extract from an unwilling witness accurate knowledge of past diseases, the family history, habits, etc. For the proper exercise of both these functions a good deal of common sense is mixed with medical skill and knowledge. He knows what impairments have practically no influence on mortality, such as flat feet, cardio-respiratory murmurs, etc., and does not cumber his report with details of inconsequential trifles. He knows that apparent disturbances of function, such as persistent albumin and persistent irregularity of pulse have a bad influence on mortality, and that organic murmurs of the heart, present evidence of tuberculosis, etc., have a worse effect. This knowledge comes in part from the general prognosis learned in medicine and in part from the special information taught by life insurance companies. This latter item could be made of increasing value by a wider publicity of the papers read at the meetings of our Association and other similar organizations. As a result the medical examiner knows that certain classes of functional and organic defects are not usually acceptable for standard insurance.

In the Mutual Life Insurance Company of New York the

medical examiner's report has contained for many years a question which reads as follows:

"Do you without reservation unqualifiedly recommend the applicant for life insurance?" The wording of this question has changed almost none from the time it was instituted in the seventies. The medical examiner's answer has been affirmative in the vast majority of cases, ranging from 94% to 97% approximately. In a small minority of 3% to 6% he answers it in the negative, or suggests postponement, or very rarely qualifies an affirmation by such an expression as "yes, except for heart murmurs, ""yes, except for family history," etc. We have kept record of these cases for many years, and when the application has been finally rejected or postponed, we have entered these cases under the sub-heading "Disapproved by the Medical Examiner." It must be understood that not all of these suggestions of the medical examiner are immediately adopted by the Company. Sometimes he makes his suggestions for postponement after having detected an irregular pulse only once, or after having found albumin in only one specimen. In some of these cases the condition may be cleared up on subsequent examination and the risk accepted for standard insurance, the only kind of insurance that we issue. In such cases the examination is not counted as "Disapproved by Examiner" but the number of these is very small. In other words we first determine the risks that are rejected or postponed and then we make a separate category of those that are "Disapproved by Examiner." In a way this represents the medical examiner's opinion of the non-insurability of a risk. How valuable is that opinion? Some companies regard it as of no value and merely ask the medical examiner to be a faithful reporter of the conditions found by him. Others evidently attach much weight to it and ask the examiner whether the risk is good, fair, poor or bad. Many however content themselves with a question similar to the one asked by the Mutual Life. They doubtless treat a negative answer, as we do, with great respect, even if a risk is occasionally accepted in spite of it.

It occurred to me that it might be possible to determine the value of these opinions of the medical examiners regarding the non-insurability of risks by correlating their results with the mortality for the first and subsequent years. Correlation may be defined as the determination of the relationship between two sets of numbers with a view to causality. It may be estimated by means of diagrams or graphs or numerically. When it is estimated numerically, Galton's method is the one usually adopted. This gives a plus coefficient when the two sets of figures rise and fall in unison, and a minus coefficient when one set of figures rises as the other falls. If there is no correlation, the result is zero.

A perfect positive correlation is indicated by a coefficient of +1 and a perfect negative correlation by a coefficient of −1. In addition it is always advisable to determine the probable errors not only of the coefficient of correlation but of all the other constants which are determined in the course of the calculation. If the coefficient of correlation is three or more times its probable error, there is strong reason to assume a causal relationship between the two sets of numbers, and this likelihood increases *pari passu* with the difference which separates the coefficient of correlation and the probable error. When the numbers to be compared are few it is possible for the coefficient to be fairly large with very little real correlation, and likewise for the coefficient to be fairly small although there may be substantial correlation. For both these reasons it is important to check up the numerical results by means of graphs and this has been done in all cases.

The following table shows the array of items which entered into the calculation. In column (1) are the years of issue. In column (x) are the percentages of those applications which were "Disapproved by Medical Examiner," as previously described in this paper. In column (a) are the mortality ratios on applications for policy year one, calculated in accordance with the method of the Medico-Actuarial Mortality Investigation. In column (b) are the mortality ratios for policy year two, in (c) for policy year three, in (d) for policy year four, in

(e) for policy year five, in (a-e) for the five policy years one to five together, in (f-j) for the five policy years six to ten together, omitting one year of issue for each policy year as the exposure terminated in 1909.

TABLE I

(1) Years of Issue	(x) Disapproved by Medical Examiner	(a) Policy Year One	(b) Policy Year Two	(c) Policy Year Three	(d) Policy Year Four	(e) Policy Year Five	(a–e) Policy Years One-Five	(f–j) Policy Years Six-Ten
1893	2.71	95.05	106.67	100.99	101.19	119.66	104.18	108.01
1894	3.30	88.43	78.80	110.55	102.90	91.05	93.35	102.93
1895	3.03	91.02	91.30	108.46	106.80	104.55	99.85	107.27
1896	2.84	104.69	97.38	121.29	103.28	113.86	107.88	99.26
1897	2.93	98.60	106.86	101.48	92.94	104.20	100.74	96.67
1898	2.84	105.74	90.57	124.14	95.53	111.80	105.49	98.67
1899	2.83	107.72	117.34	116.31	93.65	104.31	107.88	98.35
1900	2.99	100.35	95.39	87.21	101.46	96.14	96.15	92.08
1901	3.13	99.16	86.09	108.37	87.84	91.88	94.70	93.54
1902	3.22	87.15	92.46	88.12	90.92	92.30	90.15	85.33
1903	3.30	100.49	99.69	80.94	97.46	94.06	94.62	
1904	3.58	92.38	85.44	100.02	95.20	88.25	92.23	
1905	4.72	98.42						
1906	4.76	109.59						
1907	4.53	72.28						
1908	5.05	64.93						
1909	4.74	57.52						
1910	4.99	55.92						
1911	4.87	69.12						
1912	4.92	58.53						
1913	5.04	55.26						
1914	5.23	52.11						
1915	5.21	48.83						
1916	5.03	61.26						

It will be noticed that the years of issue have been divided into two sections, an older period from 1893 to 1904 and a recent period from 1907 to 1916. The years 1905 and 1906 have been omitted entirely from the calculation, for they were the years of the insurance investigation and very abnormal in many ways, too numerous to mention now.

We will first discuss the older period from 1893 to 1904. As column (x) is to be correlated with each of the subsequent

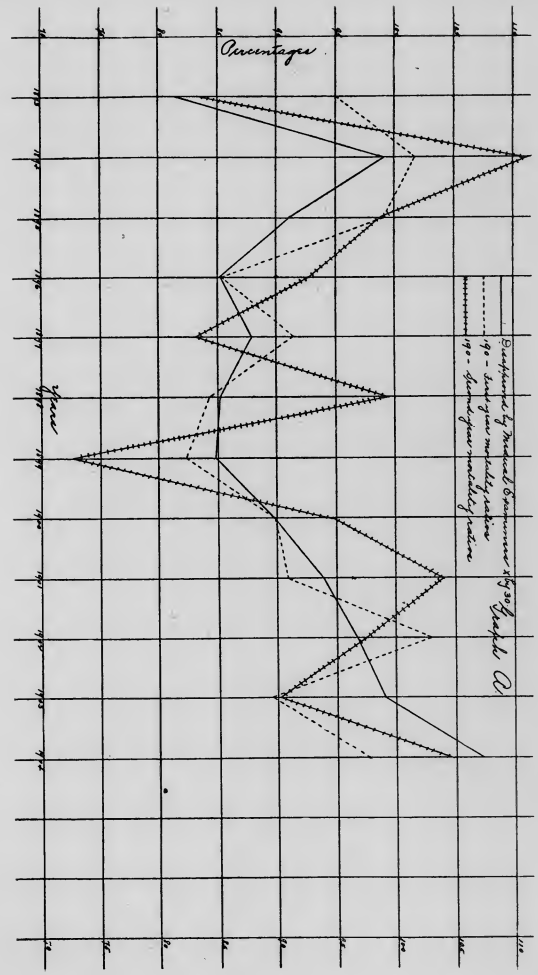
columns, it will simplify matters to set forth the constants for (x) once for all. The mean for (x), the older period, is 3.06 — ±.047. The standard deviation is .243 ± .033 and the variability is 7.9 ± 1.1. In the following table is set forth the results of correlating (x) with each of the subsequent columns. Column (1) shows the column of Table I which is correlated with (x). Column (2) shows the coefficient of correlation with its probable error. Column (3) shows the mean, column (4) the standard deviation, and column (5) the coefficient of variability.

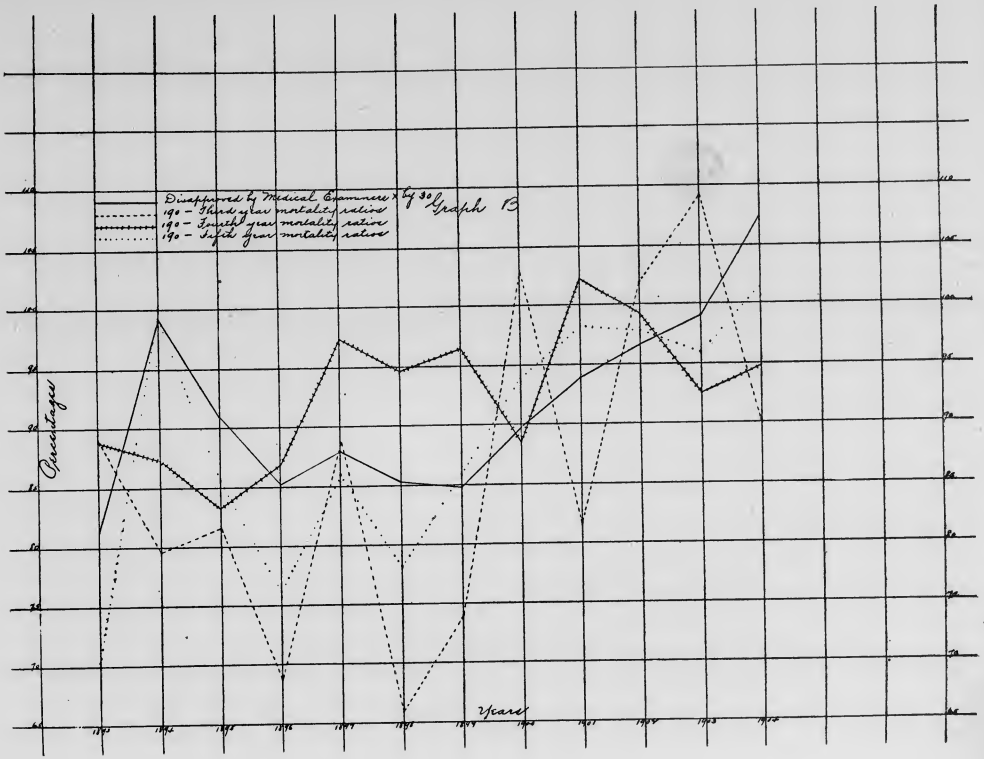
TABLE II

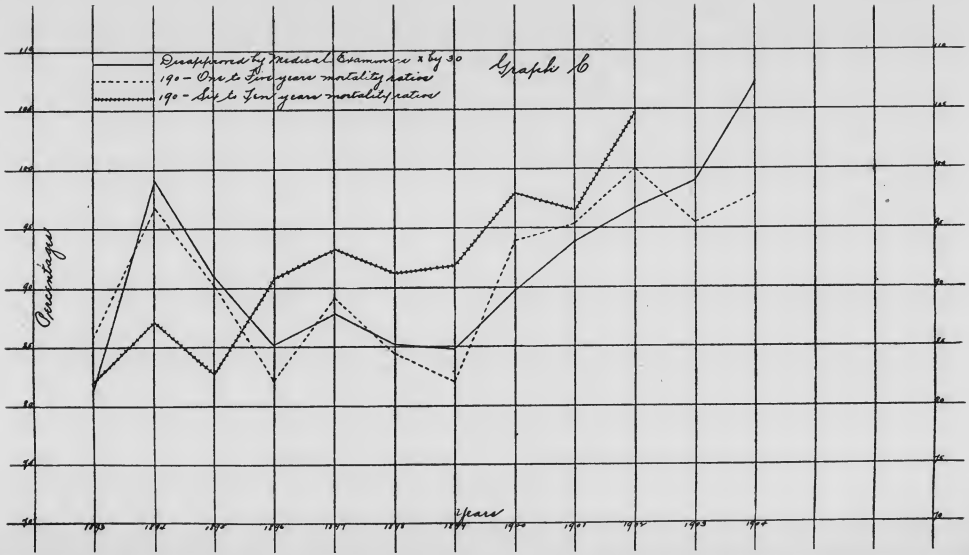
(1) Correlation of (x) with	(2) Coefficient of Correlation	(3) Mean	(4) Standard Deviation	(5) Variability
(a) 1st Year	− .563 ± .133	97.57 ± 1.268	6.511 ± .896	6.7 ± .9
(b) 2d "	− .632 ± .117	95.67 ± 2.004	10.293 ± 1.417	10.8 ± 1.5
(c) 3d "	− .445 ± .156	103.99 ± 2.536	13.023 ± 1.793	12.5 ± 1.7
(d) 4th "	− .178 ± .189	97.43 ± 1.066	5.475 ± .754	5.6 ± .8
(e) 5th "	− .887 ± .042	101.01 ± 1.911	9.816 ± 1.351	9.7 ± 1.3
(a–e) 1–5 Years	− .853 ± .053	98.94 ± 1.169	6.002 ± .826	6.1 ± .8
(f–j) 6–10 "	− .407 ± .178	98.21 ± 1.398	6.553 ± .988	6.7 ± 1.0

Column (2) is the one of interest to us. It will be noticed that every coefficient of correlation bears a minus sign, showing that the correlation is negative. This means that as the percentage of "Disapproved by Medical Examiner," increases, the mortality ratio for that year of issue decreases. Frankly this was a surprise when first noted, for the view had prevailed that an increased percentage of "Disapproved by Examiner" meant that a larger volume of poor business had been presented to the Medical Examiner and therefore it was probable that the mortality would be high.

If we take up the individual years it will be noted that the coefficient of correlation for the first policy year (a) is more than four times its probable error. For the second policy year (b) it is more than five times its probable error and for the




Disapproved by Medical Examiner x of 30
190 – Third year mortality ratios
190 – Fourth year mortality ratios
190 – Fifth year mortality ratios
Graph B
Percentages
Years


Graph 16
Disappeared by Medical Examiner x by 30
190 - Over Five years mortality ratios
190 - Under Five years mortality ratios
Percentages
Years
110
105
100
95
90
85
80
75
70
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904

third policy year (c) it is nearly three times its probable error. For the fourth policy year (d) it is less than its probable error, indicating a very poor correlation in that year, but for the fifth it jumps up to 20 times the probable error. For the first five policy years (a–e) the coefficient of correlation is fifteen times the probable error. Even for the next five policy years (f–j) it is two and a half times the probable error, and in view of the record of the previous years, that should be regarded with some respect.

That these results are due to a spurious correlation is very doubtful, since they are fairly uniform with such discrepancies as would naturally occur. In order to make sure however we can check them up by means of graphs. In order to bring the two sets of percentages in closer approximation, it is necessary to increase the smaller set. This is done for the earlier period by multiplying the "Disapproved by Medical Examiner," column (x) in Table I, by 30. The numbers in (x) are thus made to approximate in magnitude the numbers in (a), and the subsequent columns in Table I. Since (x) goes up as (a) goes down, it is much easier for the eye to appreciate the correlation between them by inverting (a) and this is done by subtracting the figures in (a) from 190. Graph A shows these changes. The continuous line indicates the "Disapproved by Medical Examiners" (x multiplied by 30), the broken line shows the mortality-ratios of the first policy year (190-a), and the crossed line the mortality-ratios of the second policy year (190-b). In graph B the broken line shows mortality-ratios of the third policy year (190-c), the crossed line those of the fourth policy year (190-d) and the dotted line those of the fifth policy year (190-e). In graph C the broken line shows the mortality-ratios of policy years 1–5 (190- (a to e) and the crossed line the mortality-ratios of policy years 6–10 (190- (f to j).

In all these graphs the correlation between the heavy continuous line which indicates the "Disapproved by Medical Examiner," and the other lines is marked. As the one rises and falls, so do the others in most cases, with the exception of the fourth policy year (d). This coincident rise and fall is

occasionally interrupted in the other policy years by a reverse current but this is exceptional. Altogether the correlations shown by the curves are close and quite as good as those by Galton's formula.

When the recent period, 1907–1916, is studied, it is evident that the two factors have quite different values from those in the older period, 1893–1904. The cases "Disapproved by Medical Examiner" have increased from about 3% to about 5%, and the mortalities of policy year 1 have decreased from an average of 97.57% to 59.58%. These changes are well shown in Table I. The years 1905 and 1906 have been omitted entirely from this study. That was the time during which the Armstrong Investigation was under way and the New York Life Insurance Companies passed through very abnormal conditions. In 1907 the new laws went into effect, and our mortalities began to assume their present values, which are on a much better plane than before.

The increase in the "Disapproved by Medical Examiner" was due to another cause. Towards the end of the last century the Mutual Life initiated a plan of salaried examiners in the larger cities and this was extended until 1903. The plan had merits but considerable friction developed with the agents in some places, and in the latter part of 1903, it was decided to abolish the salaried medical examiners. At that time, as I was starting on a vacation, I wrote a letter to the Secretary of the Company, who had recently been a Medical Director, from which I quote:

"It may be that my poetical imagination has run away with me and that the whole scheme is nothing but an iridescent dream, but I feel so strongly that there is good merit in it that I want you to consider it carefully. The scheme is as follows: To put at the headquarters of every managing agency a medical man who has been trained to perform the following duties:

1. To examine the local applicants.
2. To inspect examinations which come in from the outlying territory and if they need correction or additional information to write to the examiner for it, at the same time forwarding the original examination, with a copy of his letter to the Home Office.
3. To have the power to release policies which have been sent out subject to medical restrictions.
4. To act upon the commercial agency reports in the same way as outlined in 2 and 3.
5. To nominate medical examiners in the outlying territory at the request of the Manager.
6. To make trips into the outlying territory for the purpose of examining large risks or to perform other duties as may be assigned.

The advantages of this plan are, it seems to me, most evident on its face. It will materially facilitate the dispatch of business in every way. It will shorten the time of mail service. It will insure prompter replies from the examiners. It will have great advantage with large applications made in small towns and will undoubtedly save some business which is now lost by reason of delay in getting it properly examined. Furthermore, it will probably save some business which may be turned down by examiners in the outlying territory, for the manager will be at liberty to bring them up for examination by the local medical referee. I do not see that there is any great difficulty to overcome. The disadvantages that may be urged against the plan are as follows:

1. Impracticability. While it may be difficult to train all the men needed for these positions, I cannot see any permanent obstacle in that. Certainly the plan can be carried out as far as possible and as rapidly as possible and while it may take some time to secure such service everywhere, it can be accomplished in time.
2. Expense. I am very sure that it can be put into effect without adding any expense beyond that now paid for examinations as calculated according to the present fee system.
3. The danger of collusions between the local referee

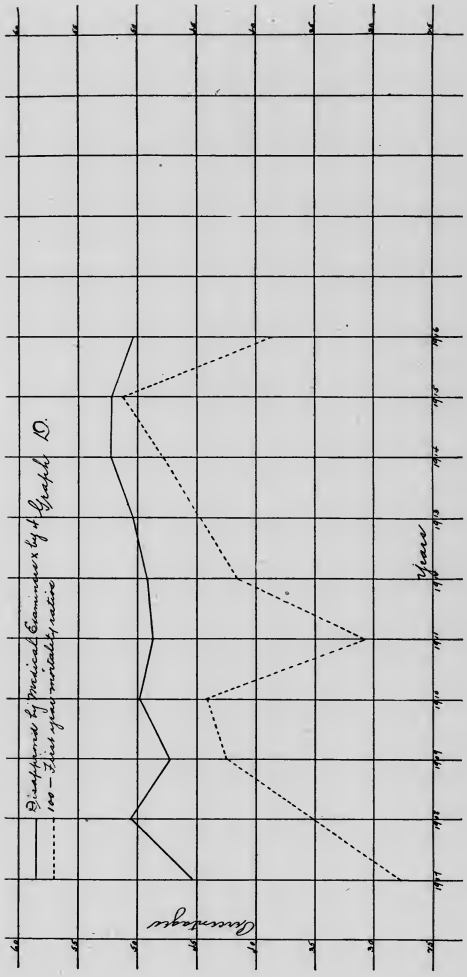
and a Manager. Certainly more damage could be done by such a collusion than is possible under the present system, but on the other hand these referees would be under closer observation than our present examiners.

I can see no drawback to the scheme other than those I have mentioned. Doubtless there are others, but they do not occur to me. The scheme is for the material benefit of the agent, and he is the one who will profit most largely and most directly by it. So far as my share is concerned it means a good deal of hard work for a few years, and from the point of self-interest it is perhaps unwise in me to urge its adoption, but I firmly believe that it will prove of great benefit to the agent and to the Company. It is at present on trial at Milwaukee and seems to be working first rate.

These suggestions were promptly adopted by the Company and we began to appoint Medical Referees on this basis as fast as we could train them. Each one received a thorough course in examining applicants and general instruction in the selection of risks at the Home Office. He made a very large proportion of the examinations in the agency city. By constant correspondence with the other examiners, he improved their knowledge of selection. Our staff of medical referees was practically completed by the end of 1906. Most of the increased percentage of "Disapproved by Medical Examiners" can be ascribed directly and indirectly to them, though some of it is doubtless due to improved medical training in general. A fraction of the gain is due to the increased volume of the business in New York City, where we have an excellent staff of medical examiners under Dr. Porter.

The correlation of the recent period is limited to policy year 1, for it was found that subsequent policy years were affected by the influenza epidemic. The coefficient of correlation is $-.751 \pm .093$. This is an excellent result and strongly corroborates the previous findings.

Graph D shows the factors in diagram. The "Disapproved by Medical Examiner" has been multiplied by 10 and the



mortalities have been subtracted from 100 in order to invert them. The lines move in unison with the exception of the year 1909.

The correlations heretofore have all been based upon consecutive years of issue. Owing to varying conditions we have been obliged to drop out two years and to split our material into two periods. It may be thought that the element of consecutive time is a factor, and without it no correlation could be shown.

Since 1912 we have kept a record of the "Disapproved" for each Agency and we also have the mortality experience for each of the New York City Agencies for the same period. The correlation for the individual policy years was not particularly good. It was usually negative but always low and often as small as the probable error. This was probably due to the small number of deaths annually in each Agency. When all the policy years —6— were combined the correlation showed better both arithmetically and graphically. The array is set forth in the following table.

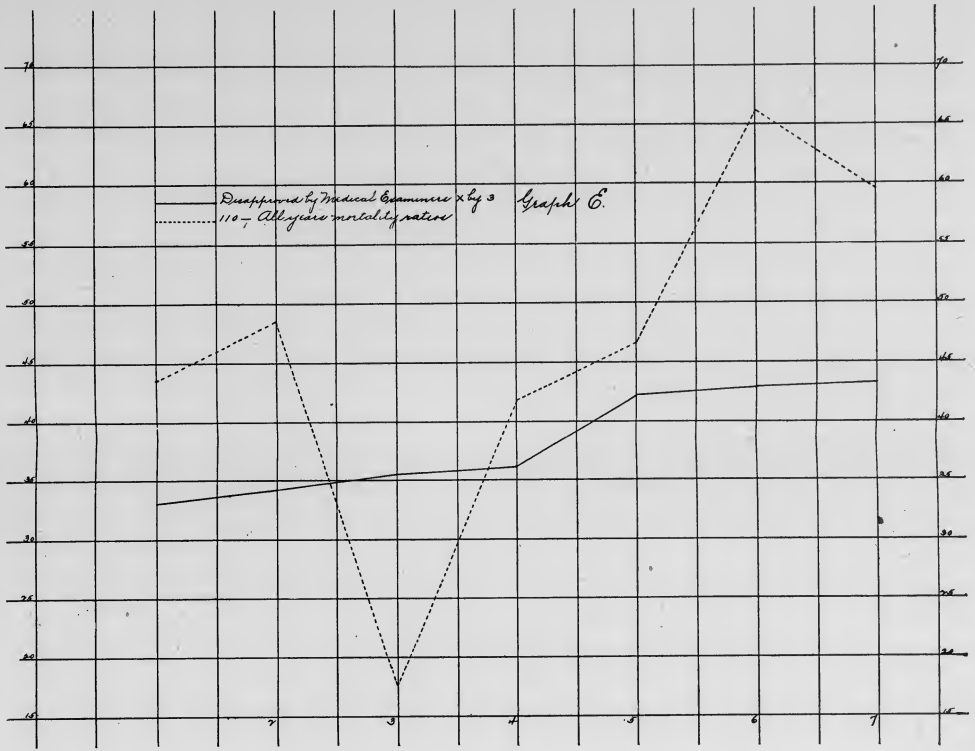
TABLE III

Agency	Disapproved by Examiner for the Years of Issue 1912–17	Mortality for the Issues of 1912–17 Exposed to 1918
1	11.0	66.5
2	11.4	61.5
3	11.8	92.3
4	12.0	68.1
5	14.1	63.3
6	14.3	43.8
7	14.4	50.4
Mean	12.71 ± .35	63.70 ± 3.64
Standard Deviation	1.38 ± .25	14.26 ± 2.57
Variability	10.90 ± 2.00	22.40 ± 4.00
Coefficient of correlation	− .622 ± .156	

In graph E the correlation is not as good as we have heretofore had. The mortality of Agency 3 is extreme and against

the current but taking it altogether the lines will be seen to move in unison. It will be noted that the percentage of "Disapproved by Examiner" was very high from 11% to 14.4%. Our examining staff in New York is excellent and has been kept up to a high state of efficiency. A great deal of instruction in the selection of risks is given to them. We all know when an applicant is disapproved by any company in New York City that he is immediately passed around from office to office in the hope that he will ultimately be accepted. As a result an expert medical examiner in New York City has abundant material for disapproval. It will also be noted that the mortalities for the New York City Agencies were very low. Considering the quality of the business that is presented as shown by "Disapproved by Medical Examiner" the record is extremely good. For the period 1912–1917, there was a total of 465.71 expected deaths and only 296 actual deaths, giving a mortality of 63.5%. For a period of 1–5 policy years the entire experience of the Company was 70.5%. The two percentages are not strictly comparable but it gives an idea how good our selection in New York City has been, so far as the early hazards are concerned.

After the "Disapproved by Medical Examiner" has been deducted from the total disapproved by the Company, there is left a residue which has been approved by the Medical Examiner but for various reasons has been considered unacceptable. This residue is composed of some who have been rejected outright on account of family history, build, personal history of disease, injury, or operation: of some who have been postponed on account of a recent illness, injury or operation, or because of a functional disturbance such as albuminuria, intermittent pulse, etc.: of some whose finances, morals or occupation are too hazardous to warrant acceptance: and of a few others. This material therefore is very heterogeneous. I tried to correlate it with the mortalities of the first, and subsequent years but obtained no results of value. The coefficients of correlation were regularly low and often smaller than the probable error. They were usually plus for the first policy


Disappeared by Medical Examiner x by 3
110 – Allgeier mortality rates
Graph E.
70
65
60
55
50
45
40
35
30
25
20
15
2
3
4
5
6
7

year but after that they were sometimes minus. It is evident that the different components of the "Residue" antagonize and neutralize one another in the determination of correlation.

Lest it be said that a beautiful correlation has been overlooked, the coefficient of correlation for the first policy year of the entire period 1893–1916 is $-.811 \pm .047$. If the abnormal years 1905–1906 are omitted, it is $-.968 \pm .009$ which is very near the perfect correlation of -1. Someone would explain this by simply showing that the low percentages of "Disapproved" are associated with high mortalities in the earlier period and that the high percentages of "Disapproved" are associated with low mortalities in the recent period. This explanation is quite correct and therefore we would not get the correct numerical value of the medical examiners' opinion. It was evidently of different significance in the two periods and it is only by analyzing the two periods separately that we can learn its real value.

We wanted to find out whether the little deviation from the mean in the percentages of "Disapproved" affected the deviation of the same year in the mortalities. The answer is definitely in the affirmative and it can be said that the mortality rises when the percentage of "Disapproved" goes down and *vice versa*. The relationship of the two can be determined numerically by means of the equations of regression, or the characteristic equations as they have also been called. If we let x represent the "Disapproved by Medical Examiner," y the mortality, r the coefficient of correlation and s the standard deviation then $x = r\frac{sx}{sy}y$ and $y = r\frac{sy}{sx}x$.

By substituting the numerical values which have already been set forth in the previous pages, these equations become for the earlier period:

$$x = -.021\,y, \quad y = -15.1\,x$$

For the recent period these equations are:

$$x = -.021\,y, \quad y = -27\,x$$

These equations indicate that in both periods a change of .021 % in the "Disapproved" was associated with an inverse change of 1% in the mortality. In the older period a change of 15.1% in the mortality was associated with an inverse change of 1% in the "Disapproved" while in the recent period a change of 27% in the mortality went with an inverse change of 1% in the "Disapproved."

The preceding work has shown that there is a substantial correlation between "Disapproved by Medical Examiner" and the subsequent mortality, even up to the tenth policy year. This correlation is not perfect for there are many other factors which enter into selection. If the applications "Disapproved by Medical Examiners" are deducted from the total disapprovals, there is a residue which is composed of some who are postponed on account of recent illness, or on account of some physical impairment, such as albuminuria, cardiac arrhythmia, etc.; others who are rejected outright on account of physique, family record and personal history of disease. This residue as a whole showed no correlation with the subsequent mortality. Those cases which were only postponed showed a small positive correlation which in the earlier period amounted to .363 ± .169 for the first policy year. It was .143 ± .191 for the second policy year and this is practically no correlation. For the later period the correlation was .464 ± .167 for the first policy year.

As this positive correlation occurs in spite of the presence of 40% of Disapproved by Medical Examiner, which would regularly show a negative correlation, the reason of it must be sought elsewhere. Most of the postponed cases other than those Disapproved by the Medical Examiner are due to the fact that the applicant has recently had some acute illness. The crude death rate of the registration area may be regarded as a reliable index of the general morbidity, for when diseases are numerous, there is also apt to be an increase in fatalities. The correlation between the crude death rate of the registration area and the Postponed in the Mutual Life for the years of issue 1907 to 1916 is .686 ± .113. The correlation between the

crude death rate and the 1st year mortality for the same issues is .704 ± .108. In both cases the correlation is good and positive. It really seems as if the percentage of Postponed and the 1st year mortality were both due to the same cause, namely, the general morbidity of the country as expressed by the death rate of the Registration Area. The correlations for the 2d and 3d policy years were obtained by excluding the deaths due to influenza. There seems to be no valid reason for doing this. When they are included the correlation for the 2d policy year becomes .368 ± .184 and for the 3d policy year .044 ± .224. For the 2d policy year the correlation is not conclusive, since it is only twice the probable error, while for the 3d policy year there is no correlation at all.

The mortality also contains an element which no medical examination can forestall entirely. The deaths from accident, homicide, and suicide cannot be prevented by the most careful medical examination and likewise the deaths from acute diseases, such as typhoid, malaria, the exanthemata, pneumonia, appendicitis, etc. Probably a certain number of the cases whose deaths are recorded from these accidents and acute diseases had some antecedent chronic ailment which would have been found by careful examination. One who already has diabetes or heart disease is less apt to survive a severe injury or an attack of pneumonia than one who is in normal physical condition. It will prove of interest to find out just how large a factor of the normal mortality cannot be prevented even by the most skillful examiner.

The United States Life Tables are based upon the census of 1910 and the deaths of the years 1909, 1910, and 1911, as found in the Registration Area, which was then considerably smaller than at present and contained a very small proportion of the Southern and remoter Western States. The following table shows the method used to calculate the unselected mortality according to the United States Life Table for white males and the distribution of exposures for the first policy year according to the experience of the Mutual Life Insurance Company for the years of issue 1907–1916.

TABLE IV

U. S. AND CANADA—ISSUES OF 1907–1916—FIRST POLICY YEAR

(1) Ages	(2) Exposures	(3) U. S. Life Table White Male 1910 qx per 1000	(4) Expected	(5) U. Acute	(6) K. Non-Acute
15–19	30,431	3.98	121.12	62.62	58.50
20–24	78,341	5.40	423.04	210.25	212.79
25–29	81,072	5.82	471.84	211.86	259.98
30–34	69,404	7.31	507.34	201.41	305.93
35–39	57,092	9.23	526.96	194.98	331.98
40–44	43,219	11.04	477.14	155.55	321.59
45–49	28,319	13.66	386.84	115.67	271.17
50–53	13,875	16.53	229.35	59.17	170.18
54–56	6,593	21.50	141.75	30.76	110.99
57–59	3,795	26.81	101.74	22.08	79.66
60–62	2,047	32.95	67.45	12.28	55.17
63–65	1,007	40.88	41.17	7.49	33.68
66–68	582	50.23	29.23	4.56	24.67
69–70	200	59.58	11.92	1.86	10.06
Total	415,977		3536.89	1290.54	2246.35
Rate per 1000			8.50	3.10	5.40
Ratio of Expected by the U. S. Life Table to M. A. Table			188.9	68.9	120.0

The expected deaths (column 4) are those supposed actually to have occurred in the year 1910 and could with all propriety be called actual deaths. When they are compared with the expected deaths as calculated by the Medico-Actuarial Mortality Table, the mortality ratio is seen to be 188.9%. Column (5) headed "u—Acute" includes those deaths due to the acute general diseases, acute articular rheumatism, meningitis, pneumonia, appendicitis, homicide, suicide, and all the other forms of external injury based upon the mortality report of the Registration Area for the year 1910. Column (6) headed "k —non-Acute" includes all the other causes of death. The death rate per 1000 of exposures is 8.50 which is divided into u = 3.10 and k = 5.40.

As we have said before, some of the deaths under u could not have been foreseen by the Medical Examiner, inasmuch as the deceased had no chronic ailment prior to the fatal illness or injury. The following table shows this quite conclusively.

TABLE V

MUTUAL LIFE EXPERIENCE—U. S. AND CANADA—FIRST POLICY YEAR

	Issues of 1893 to 1904	Issues of 1907 to 1916	New York City 1912 to 1917
Exposures	592,839	415,978	27,976
Total Deaths	2,560	1,092	60
Rate per 1000	4.32	2.62	2.14
U, Acute	1,644	658	32
Rate per 1000	2.77	1.58	1.14
K, Non-Acute	916	434	28
Rate per 1000	1.55	1.04	1.00
% of Disapproved by Examiners	3.13	5.00	12.82

Even in the early period 1893–1904, the proportion of u has dropped from 3.1 among unselected risks to 2.772. In the next period 1907–1916 it drops to 1.581 and the percentage of "Disapproved by Medical Examiner" rises to 5%. In 1912–1917 in New York City it dropped to 1.143 and the percentage of "Disapproved by Medical Examiner" rose to 12.82%. In New York City the proportion of deaths from acute infectious diseases such as typhoid, malaria, etc., is distinctly lower during the insurance ages than in the country as a whole. It hardly seems fair therefore to take that ratio as a criterion to go by. The ratio of 1.581 found in the Mutual Life Experience of 1907 to 1916 which includes the year of the United States Life Table seems to approximate the truth. It is a trifle more than one half of the ratio found among unselected risks and probably could have been improved to just about that point. Let us therefore take 1.55 which is one half of 3.1 as equivalent to u. Then k = 6.95, as that represents the rest of the total deaths per 1000, 8.5.

Up to this time I had been struggling with an equation which looked good but which failed when put to the acid tests of zero and infinity. I therefore consulted Mr. John S. Thompson, one of our actuaries, and he struggled with the problem for several days. Then he brought forth an equation and with the remark that it could probably be fitted to the facts, he left for a month's vacation. At the same time our President began to wonder audibly when this paper was going to be ready. For the next three weeks life was just one fit after another and discarded fittings were blowing up all around for the reason that they were misfits. Finally a fit was achieved which I hope will prove of interest. Mr. Thompson's equation is as follows:

$$y - u = (x^2 + k)\, a^{-x}$$

Where

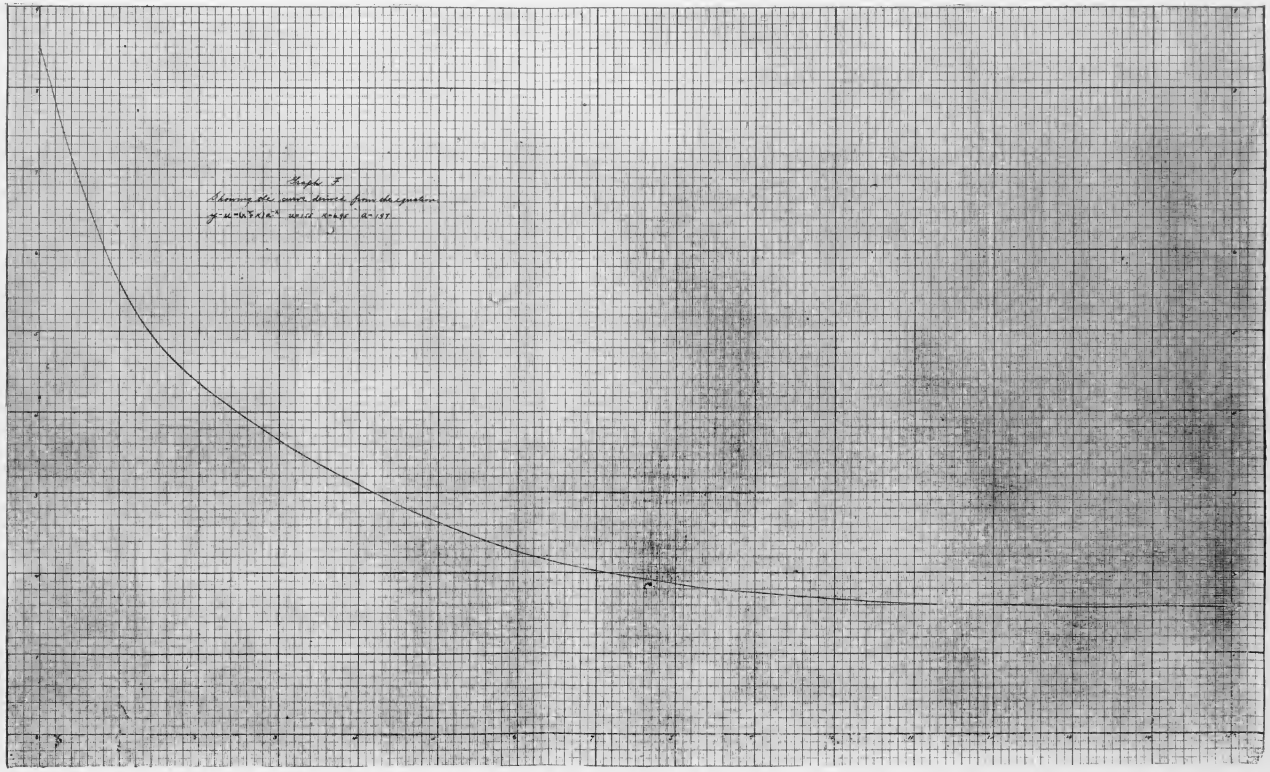
y = the total mortality as experienced in deaths per 1000 exposures. It is divided into u and k. Among unselected risks it is 8.5 per 1000 exposures.

u = That part of y which cannot be foreseen and prevented by the Medical Examiner. We have assumed that it is 1.55 per 1000 exposures.

k = That part of y which should be prevented more or less by the Medical Examiner. We assume that it is 6.95 per 1000 exposures among unselected risks.

x = The percentage of the applicants who were "Disapproved by the Medical Examiner."

a = a constant which might be termed the force of selection. In this equation $a = 1.97$ for the first policy year. Presumably it would be less for subsequent policy years. As its exponent is $-x$, its importance increases enormously as x increases for the expression a^{-x} is the denominator of the fraction whose numerator is $x^2 + k$. This seems right for the total disapprovals increase much more than the increase of those disapproved by the Medical Examiner only. The force of this expression a^{-x} is so great when a


Graph I.
Showing the curve drawn from the equation
y = 4 - 0.5 x + 0.4 x² with scale dx = .15

= 1.97 and x = 15 or any larger number that almost all the value of y is obtained from u which equals 1.55. This is a part of the equation which cannot be eliminated even if x becomes infinitely large.

Now that definite values have been assigned to u, k, and a, we can give varying values to x and then obtain the corresponding values of y. The following table shows this for integral values of x from 0 to 15, with the equivalents of y.

TABLE VI

Value of x	Equivalent of y	Value of x	Equivalent of y
0	8.500	9	1.747
1	5.586	10	1.671
2	4.371	11	1.624
3	3.636	12	1.594
4	3.074	13	1.576
5	2.627	14	1.565
6	2.285	15	1.559
7	2.036		
8	1.863		

Graph F shows the curve which these figures give. The values of x on the bottom are given, a unit to each full space. The values of y are on the left-hand side, a unit to each full space.

In the following table the actual facts are given upon which the fit has been made.

TABLE VII

(1) Value of x	(2) Theoretical Value of y	(3) Actual Value of y	(4) Exposures	(5) Actual Deaths	(6) Expected Deaths	(7) Ratio
2.38	4.062	4.034	50,814	205	223.212	91.8
3.13	3.556	4.320	592,839	2560	2637.222	97.1
4.40	2.882	2.784	90,893	253	416.366	60.8
5.00	2.627	2.625	415,978	092	1871.927	58.3
7.80	1.892	1.972	28,906	157	124.067	45.9
11.20	1.617	1.460	6,847	10	33.653	29.7
12.82	1.579	2.140	27,976	60	127.243	47.2

The headings of the column indicate the matter in each. The expected deaths (6) were calculated according to the Medico-Actuarial method. This column and also (7) were inserted simply to show the mortalities as ordinarily presented to a Medical Director, which correspond to the actual deaths per 1000 exposures as set forth in column (3).

The first line beginning 2.38 shows the results of a number of our Agencies whose percentage of "Disapproved by Medical Examiner" was below 3, and whose mortalities ran above our average in the recent period. These were nearly all rural agencies, scattered all over the country. The theoretical and actual values of y are very close.

The next line, beginning 3.13, represents the Mutual Life Experience in the older period, 1893–1904. It is not surprising that the actual value of y, .43182, is considerably larger than the theoretical value. Selection was quite different then from its present condition. We had a very liberal overweight standard, we accepted family records with two cases of tuberculosis freely on endowments, we had practically no system of inspecting our risks before we issued the policies. Summing it all up, we may say that the force of selection was substantially less than in the recent period. If we make $x = 1.78$ then the theoretical y for this period $= 4.3541$ which is very close to the actual figures. Now 1.78 is 19 points less than 1.97 the figure which we term the force of selection for the recent period. Approximately the force of selection was only nine tenths of its present value. This occurs too in spite of a fact which ought to increase x and therefore lower the theoretical value of a still further. During nearly all this period the Company was under the old system of General Agents. These did not like to swell their percentage of rejected applicants. In those days the Medical Examiner handed over his completed report to the agent. If the latter paid the fee to the Medical Examiner and then destroyed the disapproved application, nobody was the wiser and nobody very much cared. It was not until near the end of this period that it was made obligatory for the Medical Examiner to send his completed report directly to the Agency

Headquarters, whence they were all sent to the Home Office, and no agent was allowed to pay a fee to the Medical Examiner. If we could make a proper allowance for this the force of selection as represented by a would drop still further.

On the other hand it may be that the values of u and k are different in the earlier period. If we leave $x = 3.13$ and $a = 1.97$, but make $u = 2$ and $k = 8$, then the theoretical value of $y = 4.1314$, which is quite close to the actual value. This assumption, however, would make $y = 10$ when $x = 0$, i. e., among unselected risks in the population at large in the usual insurance ages.

The next line, beginning 4.40, shows the results of all of our Agencies whose percentage of "Disapproved by Medical Examiner" was 4 and below 5 in the recent period. Considering the limited number of actual deaths, the actual and theoretical values of y are close enough to call for no comment.

The next line, beginning 5, shows our entire experience in the United States and Canada for the recent period, 1907–1916. The theoretical and actual values of y are very close.

The next line, beginning 7.80, is the recent experience in a large city where we have only one Agency. Considering the limited number of deaths the approximation of the theoretical and real values of y is very close.

The next line, beginning 11.20, shows the experience in the recent period of another large city where we have only one Agency. The "Disapproved by Medical Examiners" are very large but the theoretical and actual values of y are in close accord. In fact this might be termed an ideal Agency. The Medical Examiners are faultless in their work and the management does not present to them any abnormal intrusions. The number of actual deaths is small but the mortality ratio as shown in column (7) is extraordinarily good.

The last line, beginning 12.82, shows the experience of our New York City Agencies. There is a large discrepancy between the actual and theoretical values of y. When $y = 2.140$ x ought to be 6.5. Apparently one half of the risks disapproved by our Medical Examiners at the Home Office are abnormal

intrusions. We do not discourage this for out of these risks which have been rejected by other companies we sometimes find good insurance. Certainly the mortality ratio of 47.15% obtained in New York City in recent years is good evidence of first-class selection.

The following table shows the individual years of the recent period:

TABLE VIII

Year of Issue	(1) Value of x	(2) Theoretical Value of y	(3) Actual Value of y	(4) Exposures	(5) Actual Deaths	(6) Expected Deaths	(7) Ratio
1907	4.53	2.8233	3.317	14,772	49	67.846	72.3
1908	5.05	2.6072	3.064	28,385	87	133.995	64.9
1909	4.74	2.7326	2.623	34,734	91	158.158	57.5
1910	4.99	2.6307	2.540	37,378	95	169.911	55.9
1911	4.87	2.6788	3.098	42,632	132	191.042	69.1
1912	4.92	2.6586	2.616	49,342	129	220.441	58.5
1913	5.04	2.6111	2.433	51,370	125	226.160	55.3
1914	5.23	2.5391	2.293	48,357	111	212.984	52.1
1915	5.21	2.5465	2.182	50,438	110	225.274	48.8
1916	5.03	2.6150	2.781	58,570	163	266.116	61.3
Total	5.00	2.6268	2.625	415,978	1092	1871.927	58.3

Considering the limited number of deaths in each year the actual results approximate the theoretical results closely. In 1907 and 1908 conditions were still somewhat abnormal following the insurance investigation. In 1914 and 1915 our mortality was a little lower than the theoretical value of y, but these years were also a little abnormal on account of the European War and the consequent diminution in business.

The following table shows the results for the individual years of the older period:

TABLE IX

Year of Issue	(1) Value of x	(2) Theoretical Value of y	(3) Actual Value of y	(4) Exposures	(5) Actual Deaths	(6) Expected Deaths	(7) Ratio
1893	2.71	4.546	4.282	34,083	146	153.591	95.0
1894	3.30	4.211	3.979	36,697	146	165.100	88.5
1895	3.03	4.361	4.160	36,279	151	165.889	91.1
1896	2.84	4.470	4.839	34,126	165	157.558	104.8
1897	2.93	4.418	4.492	37,363	168	170.408	98.6
1898	2.84	4.470	4.952	28,265	140	132.398	105.7
1899	2.83	4.476	4.946	46,924	232	215.404	107.9
1900	2.99	4.384	4.529	52,082	236	235.220	100.5
1901	3.13	4.305	4.415	61,375	271	273.265	99.2
1902	3.22	4.255	3.781	68,541	259	297.192	87.0
1903	3.30	4.211	4.287	74,375	319	317.467	100.5
1904	3.58	4.059	3.953	82,729	327	353.730	92.2
Total	3.13	4.305	4.316	592,839	2560	2637.222	97.1

In this table the force of selection, a, = 1.78 instead of 1.97 as in tables 7 and 8. It was there explained that the selection in the earlier period was less careful than in the recent period. This is shown in a general way by the fact that in the earlier period the total disapprovals amounted to 10.34% of the applications while in the later period these amounted to 14.41% of the applications.

I trust that with these explanations the fit of the theoretical equation to the actual figures will be granted. I would like to continue the research into the second and subsequent years, but our President has just said that the manuscript must be handed in now, in order to be printed for this meeting. If anyone can find a better equation or make a closer fit, he will be heartily welcomed.

Let us summarize our conclusions:

(1) There is a distinct correlation between the percentage of risks "Disapproved by Medical Examiners" and the mortality for the first and subsequent policy years.

(2) This correlation is negative and therefore the mortality

becomes smaller as the percentage of "Disapproved by Medical Examiner" becomes larger.

(3) The correlation decreases with the duration of insurance but shows some evidence even up to the tenth policy year.

(4) The correlation is not perfect even for the first policy year, for the Medical Examiner is only one of many factors in selection. Furthermore, he cannot be held responsible for a certain proportion of those deaths which are due to external causes and acute diseases.

(5) In order to express the correlation in a general manner, Mr. John S. Thompson has suggested the following equation:

$$y - u = (x^2 + k)\, a^{-x}$$

For definitions see page 46.

Dr. Symonds—We are very grateful to Mr. Henderson for his review of my paper and personally I wish to thank him for his criticism. With the unerring instinct of the skilled mathematician, he put his finger on the one weak spot in the mathematical framework. Naturally I sought corroboration for his opinion that the correlation for the first policy year in the early period is spurious. Mr. Thompson kindly worked out by a second degree equation this correlation which showed a correlation coefficient of $-.185 \pm .187$. I then had it worked out by means of a new set of ordinates drawn against a graphic curve and the correlation coefficient by this method was $-.057 \pm .194$. Both these coefficients corroborate Mr. Henderson's opinion that the correlation for the first policy year in the early period is spurious. I am glad that he went on to demonstrate that for policy years 1–5 together in that early period the correlation was excellent and not spurious but I am sorry that he stopped there. The correlation for the first policy year in the recent period is first class when subjected to the same treatment. Mr. Thompson fitted that to an equation of the second degree and Mr. Bliss fitted it to an equation of the third degree with the results as shown in the following table:

Year	SECOND DEGREE GRADUATION		THIRD DEGREE GRADUATION	
	(x) Disapproved by Medical Exam.	(y) First Year Mortality	(x) Disapproved by Medical Exam.	(y) First Year Mortality
1907	4.53	72.28	4.53	72.28
1908	4.72	66.86	4.81	65.28
1909	4.87	62.41	4.97	61.25
1910	4.99	58.94	5.02	58.05
1911	5.07	56.44	5.02	57.45
1912	5.12	54.92	4.98	57.30
1913	5.14	54.37	4.96	57.40
1914	5.12	54.79	4.97	57.17
1915	5.07	56.19	5.06	56.04
1916	4.98	58.56	5.26	53.43
Mean	4.96 ± .0419	59.58 ± 1.201	4.96 ± .037	59.57 ± 1.107
Standard Deviation	.19 ± .02	5.63 ± .849	.173 ± .026	5.191 ± .783
Coefficient of Correlation	−.997 ± .001		−.979 ± .009	

The correlations given above are so nearly perfect that they are almost too good. It really seems, however, as though the first year mortality and the "Disapproved by the Medical Examiner" bend together in inverse harmony in this recent period. Furthermore Mr. Bliss submitted the policy years 6–10 together in the early period to a second degree equation and determined the coefficient of correlation to be $-.495$ $.161$. This is even better than the previous results on a rectilinear basis, for the coefficient is more than three times the probable error. Altogether there is a definite correlation in the early period between the "Disapproved by Medical Examiner" and the subsequent mortality. The correlation for the first policy year in the early period is undoubtedly spurious, as Mr. Henderson has shown. It seems reasonable to suppose that this may be due to paucity of data on both sides in the early period and that when the data have accumulated enough to correct this, the correlation becomes evident and reliable, as Mr. Henderson has demonstrated for the policy years 1–5 taken together.

I think that after this extensive analysis no further question can be raised as to the fact of a substantial inverse correlation between the "Disapproved by Medical Examiner" and the mortality of the first and subsequent years. Mr. Henderson raises the point whether this correlation signifies cause and effect, and shows that an increase of the disapproved of 0.1% would increase the mortality to 2147% of the expected. This sounds terrific but he overlooks the fact that these risks are not border-line cases as he assumes. On the contrary they are physically and organically defective, and have been rejected by the Medical Examiner outright before the papers leave his hands, and his view is finally endorsed by the Medical Department. Let us apply Mr. Henderson's reasoning in detail. For the year 1916 there were 85,217 applications and 0.1% of these amounts to 85. The exposures were 58,737, the actual deaths were 157, and the death rate was 2.67 per 1,000. As this is in the recent period, which has been proved to have an excellent correlation, the regression of $y = -27x$. As the mean of the disapproved for this period is 4.96, a percentage of 5 among the disapproved corresponds to 58.50% mortality and a percentage of 5.1 correspond to 55.80% mortality. Then this additional one tenth per cent. ought to show a mortality of 26.21% of the expected according to Mr. Henderson. Now the expected deaths in that year were 4.5 per thousand by the Medico-Actuarial Table. We, therefore, multiply together $.085 \times 4.5 \times 26.21 = 10.02$. Out of the eighty-five rejected applicants therefore 10.02 are supposed to have died during the year following their rejection. Does that seem an excessive number out of 85 persons who were actually rejected by a medical examiner at the beginning of the year for physical defects such as pulmonary tuberculosis, heart disease, high blood pressure, diabetes, etc.? These are not border-line cases nor is it necessary to assume that any of them are fraudulent. Some of them might be semi-fraudulent in the sense that an applicant might have suppressed some of his previous history and only very skillful physical examination brought the real facts to light. Altogether they are bad

risks, whom a medical examiner has rejected outright for good reason.

Mr. Henderson also criticizes Mr. Thompson's equation on the ground that the first one per cent. of disapproved would show a mortality of 297. per thousand. From table 4, one per cent. of the exposures is 4159 and on this basis 1235.22 out of that number should die in the following year. This seems a very reasonable number when we reflect that this first one per cent. of rejected would be composed of these who were unmistakably ill. The following table shows the deaths that actually occurred in the Registration Area of the United States in the year 1911 from certain causes, the age-distribution being that of the entrants in the Mutual Life Insurance Company as set forth in Table 4.

Ages	Exposures Mutual Life 1907–1916	EXPECTED DEATHS FROM					Total Deaths
		Tuberculosis	Apoplexy	Cancer	Heart Disease	Bright's Disease	
15–19	30,431	35.09	.65	.74	7.27	3.26	47.00
20–24	78,341	147.28	2.66	3.28	20.06	12.93	186.21
25–34	150,476	327.74	12.43	21.10	62.44	48.60	472.31
35–44	100,311	229.11	29.89	58.79	90.98	74.93	483.70
45–70	56,418	109.39	93.89	122.27	160.40	126.88	612.83
Total	415,977	848.61	139.53	206.17	341.15	266.60	1,802.05

These five causes above account for one and a half times the deaths required by Mr. Henderson. In fact tuberculosis and heart disease show 1189.76 deaths, nearly as many as the required deaths. He then goes on to say that the tenth one per cent. of those rejected—the term is a little awkward but understandable—would show nearly double the mortality expected by the M. A. Table. Again it must be emphasized that these rejected cases are bad risks, so bad that a medical examiner has actually disapproved them. Undoubtedly the defects of the tenth one per cent. would be found only by a very

skillful examiner but that would not diminish their importance or significance.

Dr. Dwight takes a small clause out of one sentence and then preaches quite a sermon on that. It reminds one a little of the atheist who endeavored to establish his disbelief by quoting the latter clause of the first verse of the 14th Psalm but was finally subdued by his opponent who quoted the opening clause. Dr. Dwight then imagines that the low mortalities are due to overselection, as he calls it, but let me assure him that these mortalities represent the entire business of the Mutual Life in the United States and Canada for each of the years mentioned measured according to the mortality table and methods used in the Medico-Actuarial Investigation, except in the few cases where certain agencies are mentioned, some of which are bad and others good.

It is not at all surprising that companies which issue substandard policies do not place much confidence in the medical examiner's opinion on the insurability of a risk. I quite agree with Dr. Rockwell's views and the reasons therefore. We have found that by training all our medical referees, who number 63, at the Home Office, they are able to pass some of their acquired knowledge to the field examiner by correspondence, personal interviews, etc. The method seems to have succeeded very well if we may judge by the results in the last fifteen years on our mortality.

Without Mr. Thompson's help the latter part of my paper would be non-existent for it depends upon the equation which he suggested. In regard to this he wishes me to say:

"The average mortality rate of 8.5 per 1,000 was derived by applying the rates of mortality according to the United States Life Tables, 1910, to the 'Exposed to Risk,' as explained in the paper. It is, therefore, the mortality in a large sub-group of the general population distributed as to age in the same manner as the insurance in question. It was assumed that in a random selection from the population, the United States Life Table, 1910, q x would be experienced; the formula was devised to measure the effect of different degrees of selection

as applied to such a group. The selection experienced by an insurance company of course differs from that dealt with here inasmuch as it is applied to the group *applying for insurance.* Under the selection exercised by Industrial companies, the resulting mortality is considerably higher than that among the general population as is evidenced by the high rates shown in the Standard Industrial Table.

"There is no doubt that Mr. Henderson's formula is a much more general statement of the case."

While further study may modify the mathematical value of the correlation and the equation, it seems to be established that:

1—There is an inverse correlation between those risks which are disapproved by the medical examiner and the mortality. As the one increases the other diminishes, within a certain range, and a duration probably of ten years.

2—This correlation is causal, though perhaps not to the full extent indicated by the coefficients.

3—There is great value to the Company in educating its medical examiners, for the greater their skill and knowledge in insurance selection, the better is the protection to the Company.

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